fracture under heavy pressure. His friend, Mr. Stephenson, could support him in the statement, that pipe sewers were not the only ones whose ribs had been stated in. He hoped that this metropolis would be provided with a complete system of sewerage, which would be cheaper and do the work better than the present sewers did.

Mr. Trelawney Saunders proceeded to address the meeting on the burdens borne by the "unrepresented and powerless ratepayers" of Westminster, and spoke of the failure of Victoria-street Sewer, recently constructed at an enormous cost.

The Chairman interrupted his remarks, stating that the object was to discuss the engineering question of the most desirable and effective form of sewers for town drainage, and not to discuss the constitution or actions of any particular body of commissioners, who might have it entrusted to them to superintend the carrying out of works of drainage.

In answer to a question, Mr. Rawlinson said he should certainly use a brick sewer rather than a smaller sized pipe drain, where the brick sewer would be the cheaper and an equally applicable mode. At Hitchin, there were no brick sewers throughout. An entire length of drain had to be laid below the bed of the river, and he therefore preferred laying in pipes as being more easily put together, especially as there was no great pressure upon them. If it had been a valley outlet without the river, he would probably have laid down a 3-feet brick sewer. At Ormskirk, all the outlet sewers were of radiated bricks, the sewers being from 2 feet to 2 feet 6 inches in diameter. In reply to Mr. Hawkshaw, who asked what was his conclusion as to the largest size of pipes, not being socket-pipes, which it would be safe to use, the speaker said that such a question could only be decided on the spot, as much would depend on local causes; and frequently plans had to be much altered to meet obstacles and difficulties which were never expected to arise. As to the question of the thickness of the pipes, very much depended on the nature of the materials of which the pipes were to be constructed. In Manchester they were enabled to make pipes of from 2 to 2½ inches in thickness, but in London an eminent maker had informed him recently they could not be made of more than 1 inch in thickness, owing to the quality of the clay which had to be used:—even that clay had to be brought from a distance for the purpose. Many failures of which they had heard were to be attributed, not to the system of pipe drainage, but to the bad system of making the pipes. It was stated that at Croydon the 8-inch pipes were only ⅛ths of an inch in thickness. The pipes used in Manchester were made of a kind of fire-clay, and were from 2 to 2½ inches thick for the larger sizes.

Mr. G. Donaldson said that at Croydon he understood there had been pipes taken up which had been found split from end to end as it were into ribbons, and the foreman who took them up and laid pipes down again, had stated that he had found some that might be broken into pieces like biscuits, but which when exposed to the air became quite strong again in the course of a very short time.* He did not vouch for the truth of these statements, but merely gave them to the meeting as he had them told to him.

On the 30th November the discussion was continued.

Mr. Rendel (the chairman), in opening the proceedings, reminded the meeting that the question was one that demanded rather the opinion of professional men than of those who merely acquired their knowledge of the subject by reading, however extensive that reading might be.

Mr. Haywood (the City of London surveyor) said, that after having read many dozens of reports from superintending inspectors, as also the other works emanating from the General Board of Health, he was delighted to find from Mr. Rawlinson's paper that the profession were to be, at last, allowed to have some judgment in the matter of drainage. The question was one of size; and the point to determine was, what material would best form effective sewers. Up to a certain point, he thought there was little doubt that it was better to use pipes for the purposes of drainage; but, beyond that, some other material must evidently be employed. It should be remembered that a town once sewered was in a very different condition than previously; and the rainfall that might pass off without injury before drainage could not afterwards pass off without injury. If the sewers were so made as to be adapted only to take off a small rainfall, and an excessive rainfall occurred, he could not see how basements below the gulley could escape being flooded. He thought that in most districts which were urban it was wise to calculate for a large rainfall, and to provide for carrying that rainfall away; and surely it would be better to carry that and the ordinary contents of the drains away by one system of sewers than by two separate systems. It was generally thought that in Paris no fæcal matter went into the sewers, but this was a mistake, for thirty-five sewers emptied their fæcal matters into the Seine. All the hospitals, markets, barracks, and other similar buildings there emptied such matters direct into the river, and had done so for the last forty or fifty years. The question as to using pipes was one as to the size of the sewers, and as to their expense. To lay down a system of town sewers merely large enough to carry off the quantity of water that they have to carry off (a question which has yet to be settled), would be found to be a serious error. He had himself within the last two years built more than two miles of pipe drainage, but he still felt that there were dangers in the system. The first danger was as to stoppage. The experience that had yet been had in small provincial towns furnished no criterion. The stoppages in the pipes would commence after the early and careful superintendence had ceased. He had himself only met with three stoppages in the pipe sewers he had laid; the first by rubbish getting into the pipes; the second by fish cleanings; and the last by breakage. But the main difficulty of pipe sewers was, when stoppages did occur, in telling where they occurred; while in brick sewers a man was sent down, and the cause of the stoppage was at once discovered, and without the slightest inconvenience to the neighbourhood. With respect to the size, what tables were they to take? Were they to use those of Phillips or Cowie, of Roe or Austin, or of others, who had put forward tables on the subject?

Mr. Hawksley said, that very recently he had to lay main pipes 3 miles in extent and 13 inches diameter, near Whitehaven, and he found that his calculation, made according to the formula which was then on the walls of the room, had come out entirely correct. With regard to Mr. Rawlinson's paper, the first point worthy of consideration was where that paper stated that the size of the outlet sewer should be in proportion to the number of houses. Now he thought that the number of houses had nothing to do with the matter. The real point was the size of the area to be drained. As to a strictly suburban area, very little difficulty existed. The result of Mr. Roe's experiments showed that the quantity of water coming off any given area was in proportion to the extent of area. No suggestions had been made by the adoption of which water, that would otherwise flow down the streets, and flood water from the lower parts of a town, could be carried off; and yet book after book was issued treating the matter as if nothing but the sewer-water had to be removed. He was sure that the system they had heard advocated would have a deplorable effect.

Mr. Netherway said, that he had tried various experiments since the last meeting as to the weight that pipes would bear before crushing. He had tried with pipes 12 inches in diameter. The pipes were Staffordshire blue pipes 15-16ths of an inch thick, and glazed pipes 13-16ths of an inch thick; the first kind crushed with a weight of 13 cwt. placed on the centre of the pipe, and the other 14 cwt. The weight was equally distributed over the whole length of the pipe, which was partly embedded in gravel.

Mr. Ritchie (of Glasgow) said, that in Edinburgh a quantity of pipes had been laid 10 inches in diameter with 6-inch side-pipes. In twelve months the whole of the side-pipes were stopped up. In another case, pipes 15 inches in diameter would, it was apprehended, be obstructed; and the general opinion appeared to be, that all main conduits should be of such a size as to be accessible.

Mr. Parker said he would try to explain the cause of some of the failures of pipe drainage. With 12 or 15 inch pipes, the fault was often committed of leaving a space below the joint and to be filled up by chance. They ought always to be laid in clay or sand, and so arranged that the pipes should not receive all the pressure, but that the cutting should bear a part of it.

Mr. Bazalgette, the recently-appointed surveyor to the Metropolitan Sewers Commission, stated that he had never seen a sewer either constructed of pipe or brick that did not collect deposit. If such was the case, it was surely cheaper to let men go in and discover where the obstruction lay, than to have to take up a whole line of pipe sewers. If the streets were to be broken up on every occasion of obstructions occurring, great inconvenience must inevitably result. He understood from persons well acquainted with the subject, that men who were accustomed to go into the sewers lived as long on an average as other working-men. Indeed, there were many occupations connected with the production of mere luxuries which were far more unhealthy. It was not fair to compare the cost of pipe drainage, which would only half drain a town, with the cost of large brick sewers, which would carry all away.

Mr. Doulton, the sewer-pipe maker, said that he had had considerable experience in the manufacture of pipes, but the manufacture of pipes on the present system had only been carried on to its present extent for four or five years, and the improvement in those years in the manufacture of pipes had been very marked. At his establishment they were turning out weekly 14,000 feet of pipes, and they made several hundreds of miles in extent every year. He thought failures would be found to be very small in proportion to the quantity made. He was convinced that there was no difficulty in making pipes, 18 or 20 inches, sufficiently strong to bear all the pressure they were likely to be exposed to. They were now making them quite as strong and as truly as the smaller sizes of pipes could be made. If any of the pipes were insufficiently stroog, it arose either from bad materials being used, from there being imperfect vitrifaction, or from the pipes being of insufficient thickness in proportion to their diameter. He had tested the strength of pipes since the last meeting in a manner they were not likely to be tested when laid. The experiments were made at Messrs. Burton's, and the pipes were exposed to an extreme trial. They were two feet long and were supported at either end by a block of wood, there being no support between the blocks. A piece of wood, 12 inches square, was then placed on the middle of the pipes. The 18-inch pipe broke at 53½ cwt; the 15-inch pipe broke at 31 cwt.; the 12-inch pipe at 53 cwt.; and another 12-inch pipe broke at 71 cwt. The 9-inch pipe broke at 54 cwt. Another cause of failure was the improper application; but bad laying of the pipes was the greatest cause of their failing. Thus, where there was tunnelling and open cutting alternately, the pipes were exposed to unequal pressure, so that there was often an upward leverage, which caused the rigid pipes to break. He thought 2-feet pipes were quite long enough; and they did not know of any failures in the pipes they had furnished, though they had already supplied eight or ten towns with them. At Rugby, a considerable quantity of large pipes had been used, for upwards of 3,000 feet of 18 and 20 inch pipes had been laid in that town. He had heard from the local surveyor, Mr. Phillips, that the result had been most satisfactory. Upwards of 600 houses, which had been supplied under his own supervision, were now enjoying water-supply and drainage, and only one case of breakage or failure had occurred, and that had arisen from causes easily explainable.

The Chairman said, that the question they had to consider was, to what extent pipes might be judiciously used, and where brick sewers might be absolutely requisite. There were evidently numerous gentlemen who still wished to speak on the subject, and he would therefore adjourn the discussion till next week's meeting.

* Mr. Doulton offered Mr. Donaldson 1,000*l.* for an inch of this wonderful pipe.

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